

Food safety and foodborne disease in 21st century homes

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Over the past decade there has been a growing recognition of the involvement of the home in several public health and hygiene issues. Perhaps the best understood of these issues is the role of the home in the transmission and acquisition of foodborne disease. The incidence of foodborne disease is increasing globally. Although foodborne disease data collection systems often miss the mass of home-based outbreaks of sporadic infection, it is now accepted that many cases of foodborne illness occur as a result of improper food handling and preparation by consumers in their own kitchens. Some of the most compelling evidence has come from the international data on *Salmonella* species and *Campylobacter* species infections.

By its very nature, the home is a multifunctional setting and this directly impacts upon the need for better food safety in the home. In particular, the growing population of elderly and other immunocompromised individuals living at home who are likely to be more vulnerable to the impact of foodborne disease is an important aspect to consider. In addition, some developed nations are currently undergoing a dramatic shift in healthcare delivery, resulting in millions of patients nursed at home. Other aspects of the home that are unique in terms of food safety are the use of the home as a daycare centre for preschool age children, the presence of domestic animals in the home and the use of the domestic kitchen for small-scale commercial catering operations. At the global level, domestic food safety issues for the 21st century include the continued globalization of the food supply, the impact of international travel and tourism, and the impact of foodborne disease on developing nations.

A number of countries have launched national campaigns to reduce the burden of foodborne disease, including alerting consumers to the need to practice food safety at home. Home hygiene practice and consumer hygiene products are being refined and targeted to areas of risk, including preventing the onward transmission of foodborne illness via the inanimate environment. It has been said that food safety in the home is the last line of defense against foodborne disease, and it is likely that this will remain true for the global population in the foreseeable future.

Key Words: *Food safety; Foodborne disease; Home*

La salubrité des aliments et les maladies d'origine alimentaire dans les domiciles du XXI^e siècle

Depuis dix ans, on convient de plus en plus de la participation du domicile à plusieurs enjeux en matière de santé publique et d'hygiène. L'enjeu le plus compris est peut-être le rôle du domicile dans la transmission et l'acquisition de maladies d'origine alimentaire. L'incidence de ces maladies augmente sur la scène internationale. Bien que les systèmes de collecte de données sur les maladies d'origine alimentaire ratent souvent la masse de flambées d'infections sporadiques qui trouvent leur origine au domicile, il est désormais accepté que de nombreux cas de maladies d'origine alimentaire découlent d'une mauvaise manipulation et d'une mauvaise préparation des aliments par les consommateurs, dans leur propre cuisine. Certains des arguments les plus convaincants proviennent de données internationales sur les infections imputables à des espèces de *Salmonella* et de *Campylobacter*.

Par sa nature même, le domicile est un lieu multifonctionnel qui a des répercussions directes sur le besoin d'améliorer la salubrité des aliments à domicile. En particulier, la population croissante de personnes âgées et d'autres individus immunocompromis qui vivent chez eux et qui sont susceptibles d'être plus vulnérables aux répercussions des maladies d'origine alimentaire représente un aspect à envisager. De plus, certains pays industrialisés subissent un changement radical dans leur mode de prestation des soins, des millions de patients étant désormais soignés chez eux. D'autres aspects du domicile qui sont uniques en matière de salubrité des aliments sont l'usage du domicile comme service de garde pour des enfants d'âge préscolaire, la présence d'animaux domestiques à la maison et l'utilisation de la cuisine familiale pour mener des activités commerciales de traiteur à petite échelle. À l'échelle mondiale, les enjeux relatifs à la salubrité des aliments à domicile pour le XXI^e siècle incluent la mondialisation continue des disponibilités alimentaires, les répercussions du tourisme et des voyages internationaux et les répercussions des maladies d'origine alimentaire sur les pays en voie de développement.

Plusieurs pays ont lancé des campagnes nationales pour réduire le fardeau des maladies d'origine alimentaire, y compris la sensibilisation des consommateurs au besoin de respecter la salubrité des aliments à domicile. Les pratiques d'hygiène à domicile et les produits d'hygiène pour les consommateurs sont raffinés et ciblés vers des secteurs de risque, y compris la prévention de la retransmission de maladies d'origine alimentaire par les matières inorganiques. On dit que la salubrité des aliments à domicile représente la dernière ligne de défense contre les maladies d'origine alimentaire, et il est probable que ce constat s'avérera pour l'ensemble de la population dans un avenir prévisible.

THE INCIDENCE OF FOODBORNE DISEASE

There are many indicators that point to the fact that the incidence of foodborne disease is increasing globally, and is a substantial cause of morbidity and mortality worldwide. For industrialized countries in general, it has been estimated that

up to one-third of the population suffer a foodborne illness each year (1). In the United States, foodborne diseases cause an estimated 76 million episodes of illness annually (2). Although the vast majority of cases are mild, a significant number of deaths do occur and the high levels of acute infections

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and chronic sequelae lead to billions of dollars in medical costs and lost productivity (3).

It can be assumed that the prevalence of foodborne disease in the developing world is even higher (4), although it is difficult to obtain the data that would support this assumption. While it has long been considered that most cases of diarrhea in developing countries are waterborne, Kaferstein (5) has recently stated that it is a grave mistake to ignore the role of contaminated food and that there is an urgent need to integrate food safety, along with water and sanitation programs, as an essential strategy to prevent diarrhea. A recent study of campylobacteriosis in developing countries (6) gave an insight into the prevalence of *Campylobacter* species, which is the most commonly isolated bacterial pathogen from children under two years of age suffering from diarrhea. Isolation rates for children under five years of age were estimated to be between 40,000 per 100,000 and 60,000 per 100,000, compared with 300 per 100,000 in developed countries. The study found that the major sources of human infection were food and environmental contamination and a survey of retail poultry sold in Bangkok and Nairobi (6) found *Campylobacter* species contamination rates of between 40% and 77%. Coker et al (6) reported that this disease is projected to remain one of the top ten isolated bacterial pathogens globally in 2020. Campylobacteriosis is considered to be a greater burden in the developing world, partly because *Campylobacter* species-associated diarrhea and bacteremia occur in HIV/AIDS patients.

THE ROLE OF THE HOME IN FOODBORNE DISEASE

Although foodborne disease data collection systems often miss the mass of home-based outbreaks of sporadic infection, it is now widely accepted that many cases of foodborne illness occur as a result of improper food handling and preparation by consumers in their own kitchens, as shown in a review of studies from both Europe and North America (7). In addition, a study of *Escherichia coli* O157 outbreaks in the United States (8) found that 80% of suspect hamburgers were prepared and eaten at home. In Australia, approximately 90% of *Salmonella* species infections are generally thought to be associated with nonmanufactured foods and the home (9). Data available from Canada covering 1996 and 1997 has identified the home as the most common exposure setting for cases of *Salmonella* species, *Campylobacter* species and pathogenic *E coli* infection (10).

There are a number of factors which are likely to contribute to outbreaks of foodborne illness in the home, including a raw food supply that is frequently contaminated, a lack of awareness among the general public, mistakes in food handling and food preparation at home and the deliberate consumption of raw and undercooked foods of animal origin, often described as 'risky eating behaviour' (4).

Raw foods, including meat and poultry, raw eggs, fish and shellfish, and fruits and vegetables, should all be considered as potential entry sources of foodborne pathogens into the home. The list of infectious agents that have been introduced into the home via food includes species of *Salmonella*, *Campylobacter*, *Listeria* and *E coli* O157 (11).

The human and animal occupants of the home can also serve as sources of foodborne pathogens. Humans and animals can both serve as symptomatic and nonsymptomatic carriers and also as postsymptomatic excretors. Pathogens can be

transferred from various sources to inanimate contact surfaces in the home or directly to other foods or human occupants via transient carriage on the hands. Foodborne agents that have been introduced into the home via humans include species of *Salmonella*, *Shigella sonnei*, *Staphylococcus aureus*, rotavirus and hepatitis A virus (11).

The four most common mistakes in handling and preparing food at home are the inappropriate storage of food (including inadequate refrigeration, the failure to attain a required cooking and/or reheating temperature), any actions that result in cross-contamination, and the presence of an infected food handler. In a study of 101 home-based outbreaks (12), it was determined that inappropriate food storage and cross-contamination were the most prevalent mistakes, accounting for 50% and 28% of reported causative factors, respectively.

FACTORS THAT IMPACT FOOD SAFETY INSIDE THE 21st CENTURY HOME

In order to understand the challenges to food safety in the home, it is worthwhile to consider the relevant elements that comprise a typical modern-day home in this early part of the 21st century. It is also worth noting that in many parts of the world, the home is in fact a multifunctional setting comprising many activities that may have an impact on the need for, and practice of, food safety.

First and foremost, the home is a residence containing occupants of mixed ages and health statuses. In many parts of the world the numbers of immunocompromised individuals living in the community is on the increase and, amongst other things, these people are often at a higher risk for the acquisition of foodborne disease as well as for a more severe disease outcome. In the United States, the population of immunocompromised individuals is estimated at more than 30 million people (13). In many countries of the developed world, the elderly population is the fastest growing segment of the population, as for example in the United Kingdom, where there are currently nine million senior citizens, most of them living at home (14). For the developing world, one only has to consider the impact of the AIDS epidemic and the numbers of people living with HIV/AIDS to get some measure of the size of the immunocompromised populations in these areas (15).

With a dramatic shift in healthcare delivery, the home in the United States is increasingly playing a role as an extension to, or replacement for, traditional in-hospital care. It is estimated that eight million patients are now nursed at home, with 66% of them being over 65 years old (16). Again, this puts a renewed emphasis on the need for food safety in the home, much as might be expected if these patients were being cared for within the hospital.

Another growing home-based activity that may impact food safety in the home is the presence of young children in home-based daycare. In the United States, 75% of under-five-year-olds are currently enrolled in daycare (17), representing 13 million preschoolers and six million infants. Much of this child care is home-based, with 25% of all children cared for by relatives and 5% by in-home caregivers. There are many reports of outbreaks of infectious diseases, including diarrhea, in children's day care settings (18) and the potential for infection to spread within the home via food is inevitably increased in these situations. In addition, small and/or unlicensed home-based daycare settings are less likely

to have outbreaks reported and investigated, and may, therefore, miss advice and information about the importance of appropriate food safety practices.

In addition to its human occupants, the home is frequently shelter to a number of pets, ranging from mundane varieties to the exotic, and many zoonoses, including some that can cause foodborne infections, can be acquired from both. *Salmonella* species and other enteropathogens have long been recognized in association with domestic pets, such as cats and dogs (19). Household cats and dogs may also serve as reservoirs for species of *Campylobacter* and, thus, are potential sources of infection (20). Exotic pets may also serve as a source of enteropathogens into the home (21). More than 50% of homes in the English-speaking world have cats and dogs (14), with 14 million cats and dogs in the United Kingdom, 60 million in the United States and an estimated 17.8 million household pets in Australia, with three in every five Australian households containing at least one pet (22). The role of household pets in the acquisition of *Salmonella* species infections by infants was described by Schutze et al (23). It was found that infants in this study were probably more likely to have acquired infections by direct contact with inanimate surfaces, such as floors, that had been contaminated by household pets, than by the consumption of contaminated foods.

Finally, when considering the question of food safety in the home, we usually think of food that is prepared and served to the home occupants. However, we should also consider that the home kitchen may also be used for small home-based business operations that prepare food for catered functions outside of the home, as well as for bake sales, school and church picnics, etc. In all of these examples, food prepared at home is served to a wider community. These catering activities are usually unregulated, often take place in kitchens with inadequate facilities and equipment, and are carried out by people who may not have taken a training course in food safety. A study of home-based catering operations in the United Kingdom noted that food was stored inappropriately in the home kitchen on 50% of occasions (12).

GLOBAL IMPACTS ON FOOD SAFETY IN THE HOME

There are also a number of global factors that have an impact on food safety inside the 21st century home. In particular, the globalization of the food supply impacts homes all over the world.

World meat consumption is expected to double between 1983 and 2020, to 300 million metric tons, and most of this increase will occur in developing countries (24). The impact on food safety for homes in these countries may be significant, considering that meat processing may not be well regulated, home kitchens may not be equipped for storage and preparation of raw meats and the population may not be familiar with the general food safety guidelines for meat storage and preparation, especially where the consumption of large quantities of meat protein is a new phenomenon. The aforementioned study on campylobacteriosis in the developing world (6) indicates the potential magnitude of the problem surrounding poultry production.

Import statistics indicate that more than 50% of fresh vegetables in the developed world marketplace are imported from developing countries (25), prompting food safety experts to

quip that consumers only have to travel as far as the local food-market and home again to experience 'traveller's diarrhea'.

International travel and tourism to countries with poor standards of food hygiene may also impact the home. Globally, 1.6 billion people travel by air each year (26). Rapid air travel means that people who have contracted gastroenteric infections may carry these agents back into their homes, with the potential for further spread within the family and the immediate community, both directly by person-to-person contact and indirectly by cross-contamination into the food prepared at home. The potential for this type of transmission is seen in a World Health Organization report (27) that states that 64% of tourists exiting Thailand in 1995 were suffering from diarrhea.

IMPROVING FOOD SAFETY IN THE 21st CENTURY HOME

It has been said that there are three major lines of defense against foodborne disease (4). The first aims at improving the hygienic quality of raw foodstuffs; the second utilizes food processing technologies such as pasteurization and irradiation, and employs hazard analysis and critical control point (HACCP) concepts; and the third line of defense concerns the education of all food handlers, including home-based food handlers. There are a number of national campaigns, for example the Canadian Partnership for Consumer Food Safety Education in Canada (28), the Partnership for Food Safety Education in the United States (29), the Food Standards Agency in the United Kingdom (30), and international campaigns, such as the World Health Organization's Food Safety Program (31), that aim to inform and educate the general public about the need to better understand and practice food safety in the home. These campaigns are comprehensive and address real concerns, but inevitably tend to be web and print media-based and, in this respect, they are a passive form of information transfer and are likely to be taken up only by that segment of the population that is actively searching for information. In many countries, the subject of food safety was traditionally taught as a part of the home economics curriculum in schools, but in recent years the teaching of home economics has largely disappeared from many national education programs and, as a result, food safety is not taught. In addition, changes in family structure, changes in family meal practices and changes in women's roles in the home and workplace have resulted in a breakdown in the transfer of information about safe food practices within the family. With increasing concern in many countries about the levels of foodborne disease and the huge national economic burden associated with these levels, the introduction of mandatory food safety education programs across schools should be considered as a means of actively educating and engaging the population in a basic health issue.

In practical terms, food safety education and information is increasingly incorporating the targeted hygiene approach developed and described by the International Hygiene Forum in their *Guidelines for prevention of infection and cross infection in the domestic environment* (32). Targeted hygiene is a risk-based approach to hygiene practice in the home, similar to the HACCP approach so widely used in the commercial food sector. Targeted hygiene assesses the relative need for a hygiene intervention based upon the source of pathogens into the home, the potential routes of transfer of pathogens within the home and the likely risk posed by the transfer of these agents to a family member. Recommendations can then be given for

safe and effective hygiene procedures aimed at eliminating pathogens from those surfaces that present a risk, thereby reducing the risk of pathogen transfer to other sites and surfaces.

CONCLUSION

Foodborne disease will continue to be a matter of major concern around the world in the foreseeable future, despite some important national successes at reducing the levels of certain pathogens in foods resulting from better farm practices, food

processing regulations, etc. Therefore, it has to be concluded that the 21st century home will also continue to remain the last line of defense against foodborne pathogens. Public education is seen as a key factor in improving food safety practices in the home. The benefits of food hygiene education would include not only a reduction in the occurrence of foodborne illness at home, but also a population better prepared to meet the needs of the food industry and food service sectors of local and national economies.

REFERENCES

1. World Health Organization. Fact Sheet No. 237: Food safety and foodborne illness. <www.who.int/inf-fs/en/fact237.html> (Version current at September 8, 2003).
2. Mead PA, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. *Emerg Infect Dis* 1999;5:607-25.
3. Duff SB, Scott E, Malfios MM, et al. Cost effectiveness of a targeted disinfection program in household kitchens to prevent foodborne illness in the United States, Canada and the United Kingdom. *J Food Protect* 2003. In press.
4. Kaferstein FK. Actions to reverse the upward curve of foodborne illness. *Food Control* 2003;14:101-9.
5. Kaferstein F. Foodborne disease in developing countries: Aetiology, epidemiology and strategies for prevention. *Int J Environ Res* 2003;13(Suppl 1):S161-8.
6. Coker AO, Isokpehi RD, Thomas BN, Amisu KO, Obi CJ. Human campylobacteriosis in developing countries. *Emerg Infect Dis* 2002;8:237-43.
7. Scott E. A review of foodborne disease and other hygiene issues in the home. *J Appl Bacteriol* 1996;80:5-9.
8. Mead PA, Finelli L, Lambert-Fair MA, et al. Risk factors for sporadic infection with *Escherichia coli* O157:H7. *Arch Intern Med* 1997;157:204-8.
9. Jay L, Comar D, Govenlock LD. A video study of Australian domestic food-handling practices. *J Food Protect* 1999;62:1285-96.
10. Health Canada. Outbreaks, Hospitalizations and Deaths: Exposure Setting (National Notifiable Diseases Individual Case). <http://www.hc-sc.gc.ca/pphb-dgspsp/publicat/ccdr-rmtc/03vol29/29s1/29s1_7e.html> (Version current at September 8, 2003).
11. Scott E. The potential benefits of infection control measures in the home. *Am J Infect Control* 2001;29:247-9.
12. Evans HS, Madde P, Douglas C, et al. General outbreaks of infectious intestinal disease in England and Wales: 1995 and 1996. *Commun Dis Public Health* 1998;1:167-71.
13. Foegeding PM, Roberts T, Bennett JM, et al. Foodborne pathogens: Risks and consequences. Ames (IA): Council for Agricultural Science and Technology (CAST) 1994; Task Force Report No 122.
14. Scott E. Developing a rational approach to hygiene in the domestic setting. *J Infect* 2001;43:45-9.
15. Adetunji J. Trends in under-5 mortality rates and the HIV/AIDS epidemic. *Bull World Health Organ* 2000;78:1200-6.
16. Pearson ML, Banerjee SS. Home care in the United States: A national perspective. Proceedings of the 4th Decennial International Conference on Nosocomial and Healthcare-Associated Infections, 2000:137.
17. Children's Defense Fund. Children in the states: 1998 data book. Washington, DC: Children's Defense Fund Publications, 1998.
18. Klein JO. Infectious disease and day care. *Rev Infect Dis* 1986;8:521-6.
19. Bruner DW, Gillespie JW. Hagan's infectious diseases of domestic animals. London: Balliere, Tindall & Cox, 1966.
20. Moreno JS, Griffiths PL, Connerton IF, Park RWA. Occurrence of campylobacters in small domestic and laboratory animals. *J Appl Bacteriol* 1993;7:49-54.
21. Fang G, Araujo V, Guerrant RL. Animal-associated human infections. *Infect Dis Clin North Am* 1991;5:681-701.
22. Australian Social Trends 1995. Culture and Leisure Special Feature: Household Pets. Australian Bureau of Statistics, 1995. <www.abs.gov.au/ausstats/abs@.nsf/0/AF01B3D0CA8D9C9DCA2569EE0015D8CA?Open> (Version current at September 8, 2003).
23. Schutze GE, Sikes JD, Stefanova R, Cave MD. 1999. The Home Environment and Salmonellosis in Children. *Pediatrics* 1999;103:1-4.
24. Delgado CL, Courbois CB, Rosegrant MD. Global food demand and the contribution of livestock as we enter the new millennium. Washington: International Food Policy Research Institute, 1998. <www.ifpri.org/divs/mtid/dp/papers/dp21.pdf> (Version current at September 8, 2003).
25. USDA Foreign Agricultural Service Export/Import Statistics. <www.fas.usda.gov/scripts/bico/bico.asp?Entry=lout&doc=1266> (Version current at September 8, 2003).
26. International Air Transport Association. <www.iata.org/pressroom/industry_stats/2003-04-10-01.htm> (Version current at September 18, 2003).
27. World Health Organization. The world is becoming a smaller place for microbes: Diseases affecting tourists. In: Removing Obstacles to Healthy Development. <www.who.int/infectious-disease-report/pages/graph36.html> (Version current at September 8, 2003).
28. Canadian Partnership for Consumer Food Safety Education. <www.canfightbac.org> (Version current at September 8, 2003).
29. Partnership for Food Safety Education. <www.fightbac.org> (Version current at September 8, 2003).
30. Food Standards Agency. <www.foodstandards.gov.uk/hygcampaign/> (Version current at September 8, 2003).
31. World Health Organization. Department of Food Safety. <www.who.int/fsf> (Version current at September 8, 2003).
32. Beumer R, Bloomfield SF, Exner M, Fara GM, Scott E, eds. Guidelines for prevention of infection and cross infection in the domestic environment. International Scientific Forum on Home Hygiene. 1998. <www.ifh-homehygiene.org/2003/2public/2pubgu00.asp> (Version current at September 8, 2003).